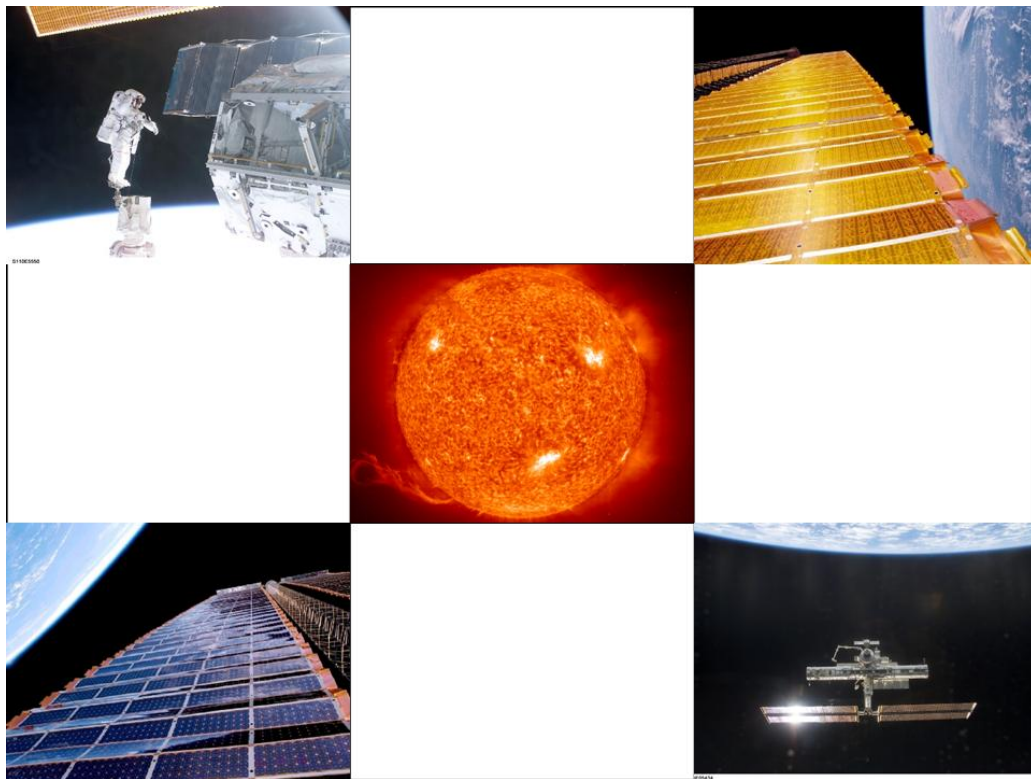




Solar Energy: It's Importance to Earth and Space Exploration

A Digital Learning Network Experience

Designed To Share



The Vision for Space Exploration

Solar Energy: Its Importance to Earth and Space Exploration

A Digital Learning Network Experience



**National Aeronautics and
Space Administration**

Designed To Share

The Vision for Space Exploration

This publication is in the public domain and is not protected by copyright. Permission is not required for duplication.



Table of Contents

Digital Learning Network (DLN) Expedition.....	4
Expedition Overview	5
Sequence of Events.....	6
National Standards	7
Texas Essential Knowledge and Skills	9
Pre-Conference Requirements	10
Expedition Videoconference Guidelines	12
Expedition Videoconference Outline.....	13
Pre-Classroom Activities	14
Post-Conference.....	23
Vocabulary	26
Resources	30
Background Information	31
Contributors and Developers	32



Digital Learning Network (DLN) Expedition

A DLN Expedition is a one time connection that allows students to experience NASA first-hand. Each expedition features an integrated educational package of grade-appropriate instruction and activities centered on a 50 minute videoconference. Students participate in a Question and Answer session with a NASA JSC education specialist or a NASA Subject Matter Expert.

The sequence for a DLN Expedition includes:

- Students complete vocabulary and Pre-Classroom Activity
- A one time DLN videoconference connection with in-formal student participation.
- Complete Post-Activity Assessment and complete online evaluation for teacher and students.



Expedition Overview

Grade Level 9-12

Focus Question

What impact does solar energy have on future developments to generate electricity on Earth and for long duration space travel?

Instructional Objectives

Students will understand the importance of energy.

Students will discuss the historical foundations of energy and its production.

Students will understand the two forms: particle and wave, and two types: kinetic and potential energy.

Students will understand how NASA utilizes the sun and solar cells to run missions.

Students will understand future uses for energy in space travel and here on Earth.

Students will identify careers associated with energy studies.

Students will understand the difference between fission and fusion.

National Standards

National Science Education Standards (NSES)

Science as Inquiry – Content Standard A

Physical Science – Content Standard B

Life Science – Content Standard C

Earth and Space Science – Content Standard D

Science and Technology – Content Standard E

Science in Personal and Social Perspectives – Content Standard F

History and Nature of Science – Content Standard G

National Council of Teachers of Mathematics (NCTM)

Measurement - Standards 12C, 13B

International Technology Education Association (ITEA)

Energy and Power Techniques – Standard 16A

Texas State Standards

5.8 Science Concepts – Standard B

6.9 Science Concepts – Standard B

8.2 Science Processes – Standards A, C

SEQUENCE OF EVENTS

Pre-Conference Requirements

Online Pre-assessment A pre-assessment tool is available to determine the students' level of understanding prior to the videoconference. Suggested answers are included.

Expedition Videoconference

Expedition Videoconference (About 45-60 minute conference)

Travel through time as we see how solar energy was used in the past, how it is used today, and how it could be used in the future. Learn about the various forms of energy and how it is being used at NASA for missions in space. See first hand how solar cells work and how they are used to power the ISS and the rovers on Mars.

Post-Conference Requirements

Online Post-assessment

A post-assessment tool is available to determine changes in student levels of understanding.

NASA Education Evaluation Information System (NEEIS) Feedback Forms

Educator and student feedback forms are available online for all DLN events.

Post-Conference Requirements

Online Post-assessment

A post-assessment tool is available to determine changes in student levels of understanding.

NASA Education Evaluation Information System (NEEIS) Feedback Forms

Educator and student feedback forms are available online for all DLN events.



National Standards

National Science Education Standards (NSES)

National Education Standards <i>Science</i>	Potential or Kinetic?	Angles and Electricity	Chain Reaction
<u>Content Standard A: Science as Inquiry</u>			
Abilities Necessary to do Scientific Inquiry	X	X	X
Understanding About Scientific Inquiry	X	X	X
<u>Content Standard B: Physical Science</u>			
(K-4) Position and Motion of Objects	X		
(5-8) Transfer of Energy		X	
(9-12) Chemical Reactions			X
(9-12) Conservation of Energy and Increase in Disorder			X
<u>Content Standard C: Life Science</u>			
Regulation and Behavior			
<u>Content D: Earth and Space Science</u>			
Earth in the Solar System			
<u>Content Standard E: Science and Technology</u>			
Abilities of Technological Design	X	X	X
Understandings About Science and Technology	X	X	X
<u>Content Standard F: Science in Personal and Social Perspectives</u>			
Natural Hazards			
Risks and Benefits			
<u>Content Standard G: History and Nature of Science</u>			
Science as a Human Endeavor			

National Council of Teachers of Mathematics

National Council of Teachers of Mathematics <i>Mathematics</i>	Potential or Kinetic?	Angles and Electricity	Chain Reaction
Measurement			
12C: Understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume		X	
13B: Select and apply techniques and tools to accurately find length, are, volume, and angle measures to appropriate levels of precision		X	

International Technology Education Association

International Technology Education Association <i>Technology</i>	Potential or Kinetic?	Angles and Electricity	Chain Reaction
Energy and Power Techniques			
16A: Energy comes in many forms	X		



Texas Essential Knowledge and Skills

Texas Essential Knowledge and Skills

Texas Science Essential Knowledge and Skills TAKS Objectives Science	Potential or Kinetic?	Angles and Electricity	Chain Reaction
<u>Objective 1: The student will demonstrate an understanding of the nature of science</u>			
Scientific processes	X	X	X
<u>Objective 2: The student will demonstrate an understanding of the life sciences</u>			
Scientific concepts	X	X	X
<u>Objective 3: the student will demonstrate an understanding of the physical sciences</u>			
Scientific concepts: the student knows that complex interactions occur between matter and energy	X	X	X
Scientific concepts: the student knows that energy comes in many different forms	X	X	X
<u>Objective 4: The students will demonstrate an understanding of the earth sciences</u>			
Scientific concepts	X	X	X



Pre-Conference Requirements

Pre-Assessment

A week before the event, students will need to take the pre-conference assessment. This short assessment will provide useful background information for the presenters to prepare for the videoconference.

Pre-Conference Assessment Questions

1. What is our primary source of solar energy in space?
2. Define energy.
3. How did Newton contribute to our current use of energy?
4. Heinrich Hertz is known for what?
5. What are the two types of energy?
6. How is light related to energy from the sun?
7. Why would energy sources be important to NASA?
8. How is solar energy used on Earth?
9. What are the three types of propulsion NASA could use for future travel to Mars?
10. What is fission?
11. What is fusion?
12. Which process, fission or fusion, is occurring constantly on the sun's surface?



Pre-Conference Requirements

**Teacher's Page with suggested answers:
Answers to Pre and Post Assessment Questions**

- 1. What is our primary source of energy in space?** The Sun
- 2. Define energy.** Energy is strength or power to work or be active; force; vigor; the power of certain forces of nature to do work
- 3. How did Newton contribute to our current use of energy?** First scientist to argue that light energy was not waves but in particles.
- 4. Heinrich Hertz is known for what?** Concluded that light energy was actually waves, but that above a certain frequency the particle jumped. This later was coined by Einstein as dual nature, they were both waves and particles.
- 5. What are the two types of energy?** Potential and Kinetic energy
- 6. How is light related to energy from the sun?** Light is absorbed by solar cells, which convert it to electricity.
- 7. Why would energy sources be important to NASA?** It provides a means for us to power the ISS, our rovers on Mars, and possibly future missions into space.
- 8. How is solar energy used on Earth?** As renewable energy to power homes, cars, and buildings. Future uses are endless as technology advances.
- 9. What are the three types of propulsion NASA could use for future travel to Mars?** Chemical, solar-electric, and nuclear propulsion
 - a. Chemical – uses materials and processes similar to what we use to launch with currently.
 - b. Solar-electric – uses a combination of solar arrays and liquid oxygen + hydrogen to start (Newton's first law: small force, exerted continuously will cause acceleration to grow slowly.
 - c. Nuclear uses higher thrust but public perception of its use is negative
- 10. What is fission?** Is the splitting of an atomic nucleus resulting in the release of large amounts of energy
- 11. What is fusion?** Is the joining together of atomic nuclei to form heavier nuclei resulting in the release of enormous quantities of energy
- 12. Which process, fission or fusion, is occurring constantly on the sun's surface?** Fusion



Expedition Videoconference Guidelines

Audience Guidelines

Teachers, please review the following points with your students prior to the event:

- Videoconference is a two-way event. Students and NASA presenters can see and hear one another.
- Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.
- Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
- Teacher(s) should moderate students' questions and answers.

Teacher Event Checklist

Date Completed	Pre-Conference Requirements
	1. Print a copy of the module.
	2. Have the students complete the pre-assessment.
	3. Email questions for the presenter. This will help focus the presentation on the groups' specific needs.
	4. Review the Audience Guidelines, which can be found in the previous section.
	Day of the Conference Requirements
	1. The students are encouraged to ask the NASA presenter qualifying questions about the Expedition.
	2. Follow up questions can be continued after the conference through e-mail.
	Post - Conference Requirements
	1. Have the students take the Post-Assessment to demonstrate their knowledge of the subject.
	2. Use the provided rubric as guidelines for content and presentation criteria.
	3. Teacher(s) and students fill out the event feedback.



Expedition Videoconference Outline

Introduction to Expedition Videoconference

Travel through time as we see how solar energy was used in the past, how it is used today, and how it could be used in the future. Learn about the various forms of energy and how it is being used at NASA for missions in space. See first hand how solar cells work and how they are used to power the ISS and the rovers on Mars.

Outline for Video Conference

- I. Welcome
- II. Introduction
- III. Historical Foundations of Energy
- IV. Understanding Forms of Energy
- V. NASA Energy Aboard ISS
- VI. Solar Cells Demonstration
- VII. Future Uses of Energy
- VIII. Careers/Website
- IX. Q&A
- X. Good-Bye



Pre-Classroom Activities



Activity: Chain Reaction

Article: Destination Mars



For 25 years, robotic rovers have been traveling to Mars. Now researchers and scientists want to send *humans*. When humans travel to Mars, they won't be going by Space Shuttle. The Shuttle is designed specifically for low-Earth orbit, and Mars is more of a long-distance flight. Larry Kos, an aerospace engineer focusing on future flight technologies at NASA's Marshall Space Flight Center in Alabama, says there are three categories of likely travel to the red planet: chemical, solar-electric, and nuclear thermal propulsion.

Chemical propulsion uses materials and processes similar to the Delta 3 rockets in use now, Kos says. Part of the craft drops away once the initial launch propellants have been used; the fuel requirements for a spacecraft to Mars are much greater making the rocket heavier. Where the Delta rocket has one 25,000-pound thrust engine, Mars-bound rockets would need four." The technology and mechanics of chemical propulsion is already in existence.

Solar-electric propulsion (SEP) uses a combination of solar arrays and a liquid oxygen plus hydrogen kick stage to get the craft going. The use of solar power minimizes the amount of fuel and mass required for departure, Kos says. The down side of SEP is that it has a low **thrust**. "SEP uses Newton's first law—that a small force, exerted continuously, will cause acceleration to grow very slowly," Kos says. "It's like the snowball-rolling-down-the-hill gathering momentum."

While chemical propulsion uses two powerful bursts of energy—one to attain mid-Earth orbit, and one to continue into interplanetary space—SEP makes many smaller orbits, each one spiraling out just a bit more. These continually spiraling orbits gradually increase in velocity, until they reach the proper speed to launch the second stage—the chemical stage—into space. It takes one year for the spiraling orbits to reach the proper speed. That adds tremendously to the time involved in a trip to Mars. One year is how long it takes to reach the secondary launch speed. From the secondary launch it is an additional 180 days to reach Mars. During that year of -increasing orbits, astronauts would not be aboard the spacecraft. They'd

board it by means of a crew taxi vehicle, which would take the astronauts out to rendezvous with the spiraling craft just before it's ready to be propelled on its way to Mars.

Nuclear Propulsion is as lightweight as the SEP method, but it has the benefit of using the higher thrust propulsion of chemical rockets. It would take hours, rather than a year, to leave Earth's vicinity. The down side? Public perception, Kos says, is anti-nuclear. "Nuclear thermal propulsion is enriched uranium, not plutonium, so it is less radioactive by a factor of 100,000."

A trip to Mars is much more complex, both in scale and in distance, than any other space travel project contemplated to date. In order to have the supplies needed to set up facilities on the planet, multiple trips to Mars will be required. It just isn't practical to try and load everything onto one rocket. While options vary, depending on the type of propulsion used, researchers expect that a trip to Mars would entail six to eight individual launches.

In the first launch, the propellant production equipment would go ahead of the crew, land, and start robotically building propellant for the return trip. During the same trip, the habitat module would also go ahead of the Mars crew to be ready for the crew when it lands on Mars. Two or three launched vehicles would rendezvous in space, and their combined stages would be used to leave low-Earth orbit to deliver the payload for an eventual landing on Mars.

Even though science fiction movies depict the landing of a large rocket on the surface of Mars, the **transit** habitat would stay in orbit above the planet—much the way the command module did for Moon landings—while the crew lander takes a surface habitat to ferry astronauts down to the surface. The command module would also provide the transportation back to Earth; this, in combination with a small ascent capsule, saves the need for developing another rocket strong enough to blast off from the Mars surface.

The timetable for a human landing on Mars isn't definite, but scientists are hoping that the first Mars **stacks** might leave Earth around 2016, land around 2018, and return to Earth in 2020.

A flight to Mars depends on precise timing. The alignment of the planets allows for an optimal launch to take place every 26 months, Kos says. To launch at any other time would make it much more difficult for the rocket and the planet to be in the right place at the right time. Staggering launches like this would mean that multiple launches would need to be paced on a 26-month schedule, so a return trip back from Mars could only take place after the planets were again aligned properly.

Mars is about 1,000 times farther away than the Moon, Kos says, but the logistics of interplanetary speed means that it would only take about 50 times as long as a Moon voyage to arrive at Mars: Apollo 11 took 4 days to reach its destination; Mars travel will take about 180 days.

Right now, we're not ready to go to Mars, Kos says. The risk of failure is too high, there are too many details to be resolved, and public support needs to be there. "We're headed in that direction, though, and that's what matters. Hopefully, at some point, we'll consider a Mars trip as routine as a Space Shuttle launch."

Courtesy of NASA's Space Operations Mission Directorate

Chain Reaction

Teacher Sheet(s)

Objective: To simulate a chain reaction.

Level: 9-12

Subjects(s): Chemistry

Prep Time: Less than 10 minutes

Duration: 40 minutes

Materials Category: Special Requirements

National Standards:

Science: 3a, 3e

Math:

Technology (ISTE):

Technology (ITEA):

Materials: *(per group of three to four)*

- 15-30 dominoes

Related Links:

[NASA Space Transportation](#)

[Applet: Nuclear Chain Reaction](#)

Supporting Article:

Destination Mars

Pre-Lesson Instruction:

- Divide students into groups of three to four.
- Each group of students will need 15 to 30 dominoes.
- Each group will need to work on a table or on the floor.

Background Information:

For a manned mission to a distant planet like Mars, a nuclear-propulsion system or nuclear-thermal system seems to be more advantageous in terms of propulsive power than a chemical system as a result of some basic differences. The two main features that lead to the advantages of a nuclear-thermal rocket over a chemical one

are the enormous energy available per unit mass of fission (or fusion) fuel, and that in a nuclear-thermal system the energy-producing medium is separate from the thrust-producing propellant.

Nuclear systems can use propellants of low molecular weight, which increase the propulsive force per unit propellant flow. The low molecular weight of the propellant permits for the use of a greater proportion of the total weight placed in space to be composed of the actual payload and not of the propellant. Low molecular weight propellants give mission designers a degree of flexibility for mission design that is not permitted by the chemical-propulsion system. With the use of a nuclear-propulsion system, mission designers can design missions that are more scientifically complex in nature because more equipment can be taken up into orbit.

Guidelines:

1. Read the article, "Destination Mars," and discuss the three methods of rocket propulsion.
2. Distribute dominoes.

Discussion/Wrap-up:

- Have students generate a list on the board of the advantages and disadvantages of a fission-propulsion system.
- Have each student write a paragraph summarizing a chain reaction.

Extensions:

- Demonstrate a model of a nuclear chain reaction. Assemble 30 to 50 mousetraps on a table, preferably next to a wall. Gently place a ping-pong ball on each set mousetrap. Drop a single ball onto the center of the assembly to start the demonstration. Within seconds there are balls flying everywhere, and, just as suddenly, the demonstration is complete. Each mousetrap represents the nucleus of a uranium or plutonium atom, and each ball represents a neutron. When fission occurs, a nucleus splits into several pieces, and also emits a number of neutrons. Each of these neutrons can strike other nuclei, causing fission. When a mousetrap is triggered, it propels the two balls into the air, which may then set off other traps. By setting the mousetraps next to a wall, this will maximize the possibility of any neutrons rebounding and initiating more neutron releases.
- Discuss the differences between nuclear fission and fusion.

Chain Reaction

Student Sheet(s)

Background Information:

Nuclear propulsion is a very attractive option for human exploration and development of space. Nuclear fuel could enable rapid, affordable access to any point in the solar system. The first step toward using advanced fission-propulsion systems is development of a safe, affordable fission system. Fission is one of the advanced concepts studied at NASA's Marshall Space Flight Center in Huntsville, Alabama.

A tremendous amount of energy is required to send a spacecraft to other planets and destinations within and beyond our solar system. Current systems have essentially pushed chemical rockets to their performance limits. The energy density of fission is 10 million times that of chemical reactions, such as the liquid oxygen/hydrogen combustion used to power the Space Shuttle. Applying fission to a soda can full of uranium—about 2 pounds—could produce as much energy as 100 Shuttle external tanks or 52 million gallons of liquid oxygen and hydrogen propellants.

Fission propulsion was worked on intensely during the Apollo years. In its current form, fission propulsion could be used to transport humans to Mars or to send sophisticated robotic probes into the outer reaches of the solar system. A trip to Mars could take less than 3 months and a journey to Jupiter could be completed in less than 1 year.

A well-designed fission-propulsion system would be inexpensive to build. Systems could be designed to operate for only a few hours or up to 20 years, depending on mission requirements. The fission process would initiate in space with the splitting of uranium fuel into two or more elements, resulting in liberation of tremendous amounts of energy. The fuel is nonradioactive throughout prelaunch activities and the launch itself, and does not begin accumulating radioactive material until it has started up in space.

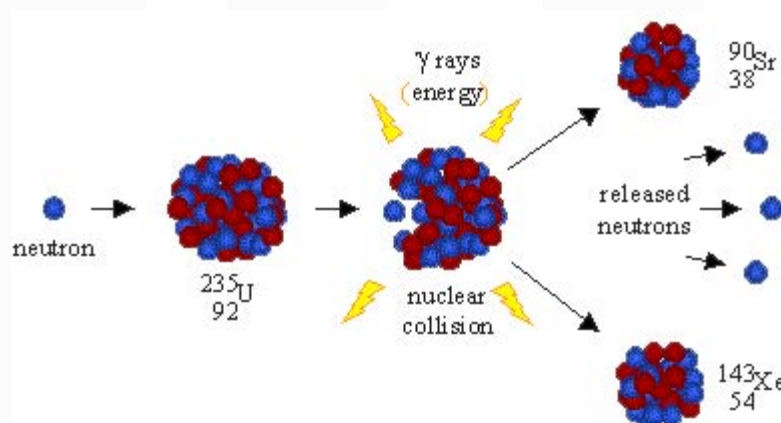
Despite their tremendous potential for enhancing or enabling deep-space and planetary missions, space fission systems have only been used in Earth orbit. The U.S. and the former Soviet Union have flown fission systems that provide power to satellites.

Besides reducing the cost of this type of space mission, nuclear-propulsion systems also have advantages for the crew in terms of time and health. For the crew, the use of a nuclear-propulsion system means a minimized exposure time to microgravity, solar flares, and ambient space radiation, and a greater portion of the mission spent on the target planet.

Microgravity over prolonged periods of time can be detrimental to the health of crewmembers. This reduction in gravity causes the loss of calcium from the bones and the loss of muscle tissue, which may result in a crew that is incapable of carrying out the tasks necessary for its survival. The minimum exposure to this phenomenon, which results from the use of a nuclear-propulsion system, provides mission designers with a high degree of confidence that the crew will be able to carry out mission tasks both during the transfer orbit and during the exploration of the destination planet.

Nuclear Fission is a reaction in which an atom's nucleus splits into smaller parts, releasing a large amount of energy in the process. Most commonly, this is done by 'firing' a neutron at the nucleus of an atom. The energy of the neutron 'bullet' causes the target element to split into two (or more) elements that are lighter than the parent atom.

The Fission Reaction of Uranium-235



During the fission of U235, three neutrons are released in addition to the two daughter atoms. If these released neutrons collide with nearby U235 nuclei, they can stimulate the fission of these atoms and start a self-sustaining nuclear chain reaction. This chain reaction is the basis of nuclear power. As uranium atoms continue to split, a significant amount of energy is released from the reaction. The heat released during this reaction is harvested and used to generate electrical energy.

A chain reaction, once started, continues without further outside influence. Proper conditions for a chain reaction depend not only on various external factors, such as temperature, but also on the quantity and shape of the substance undergoing the reaction. A chain reaction can be of various types, but nuclear chain reactions are the best known. A line of dominoes falling after the first one has been pushed is an example of a mechanical chain reaction; a pile of wood burning after it has been kindled is an example of a chemical chain reaction. In the latter case each piece of wood, as it burns, must release enough heat to bring nearby pieces to the kindling point. The wood, therefore, must be piled close enough together so that little heat is lost to the surrounding air.

In the case of the fission of a nucleus, the reaction is begun by the absorption of a slow neutron. When one atom fissions, a certain amount of energy is released, along with (let us say) two neutrons. If those extra neutrons cause two more atoms to fission, then twice as much energy is released along with four more neutrons. The new neutrons may cause another four atoms to fission, adding four times as much energy and eight more neutrons; so the total energy grows, doubling with each new generation of neutrons. The result is a stupendous release of energy.

Procedure:

1. Obtain a set of dominoes (around 30). Arrange and set up the dominoes so that when one falls, it will knock over the succession. Make a sketch of your design.
2. Knock over the lead domino. Observe the effect on the other dominoes. Observe the effect on the other dominoes.
3. Would you call this an expanding (out of control) or limited (controlled) chain reaction? Why?
4. Set up the dominoes again. This time set up only a few dominoes the same way as in the first arrangement. Arrange the others so that when they fall, they will knock over only one other domino or none at all. Make a sketch of your design.
5. Knock over the lead domino. Observe the reaction. Is it an expanding or a limited chain reaction? Why?
6. What could you do to stop the reaction once it begins?
7. Do you think this method would be equally useful in stopping the reaction when the number of dominoes is increased? Why?
8. How is the domino simulation like a nuclear chain reaction?
9. How is it different?



Questions:

1. Define the term nuclear fission and nuclear fusion. Which process results in the production of a heavier nucleus? Which results in the production of smaller nuclei?
2. How do the energies released by nuclear processes compare in magnitude with the energies of ordinary chemical processes?
3. What is the source of the energy released during nuclear fission?
4. Describe the concept of a chain reaction.
5. Explain why a chain reaction keeps going.
6. The explosive power of an uncontrolled nuclear chain reaction can be illustrated by means of a simple mathematical analogy. Imagine a job that pays 2 cents the first day, 4 cents the second day, 8 cents the third day, and so on, doubling each day. How much money will such a job earn over a 60-day period?
7. Can you think of another way to model a nuclear chain reaction?

8. Explain what advantages and disadvantages there might be to using nuclear fission in spacecrafts.



Post-Conference

Online Post-Assessment

After the event students will need to take the post-conference assessment. (These questions are the same questions used in the pre-assessment.) The short assessment will help us measure student learning and identify any changes that need to be made in future programs.

Post-Conference Assessment Questions

Grades 9-12

1. What is our primary source of solar energy in space?
2. Define energy.
3. How did Newton contribute to our current use of energy?
4. Heinrich Hertz is known for what?
5. What are the two types of energy?
6. How is light related to energy from the sun?
7. Why would energy sources be important to NASA?
8. How is solar energy used on Earth?
9. What are the three types of propulsion NASA could use for future travel to Mars?
10. What is fission?
11. What is fusion?
12. Which process, fission or fusion, is occurring constantly on the sun's surface?



NASA Education Evaluation Information System (NEEIS)

Please complete an online evaluation form to provide feedback on the NASA Challenge.

Feedback from you and a few of your students would be appreciated.

<http://dln.nasa.gov/dln/content/feedback/>

National Aeronautics and Space Administration



NASA Digital Learning Network

presents

Certificate of Completion

to

for
Completing the Solar Energy: Transfer to
Conservation Expedition

Instructor

Date



Vocabulary

Guidance: any of various processes for guiding the path of a vehicle, especially a missile, by means of built-in equipment

Navigation: the guidance of ships or aircraft from place to place

Gyroscope: a device consisting of a spinning mass, typically a disk or wheel, mounted on a base so that its axis can turn freely in one or more directions and maintain its orientation regardless of any movement of the base

Attitude: the position of an aircraft or spacecraft determined by the relationship between its axes and a reference datum (as the horizon or a particular star) ; Of an aircraft in flight, the angle made by its axes with the relative airflow

Arrays: order; a regular and imposing arrangement

Masts: a pole that extends outward and holds the solar panels on the International Space Station; a vertical pole that extends from a ship to support its sails

Solar Energy: usable power derived from the Sun

Light Spectrum: a band of color formed when a beam of white light is spread (as by passage through a prism) so that its different wavelengths are arranged in order

Atmospheric: of, relating to, or occurring in the atmosphere

Photovoltaic: capable of producing a voltage when exposed to radiant energy, especially light

Energy: strength or power to work or be active; force; vigor; the power of certain forces of nature to do work

Heat Transfer: The transfer or exchange of heat by radiation, conduction, or convection within a substance and between the substance and its surroundings.

Wavelength: a measure of a light; the peak – to peak distance one vibration of an electromagnetic wave

Solar Cell: a type of generator that produces electricity whenever sunlight shines on it

Kinetic Energy: The energy that an object has by virtue of its motion.

Potential Energy: The energy that an object has by virtue of its position in a field.

Battery: a cell or connected group of cells that converts chemical energy into electrical energy by reversible chemical reactions and that may be recharged by passing a current through it in the direction opposite to that of its discharge—called also storage cell

Power: The rate at which work is done or energy is released.

Nuclear: Of or relating to atomic nuclei

Fission: the splitting of an atomic nucleus resulting in the release of large amounts of energy

Fusion: the joining together of atomic nuclei to form heavier nuclei resulting in the release of enormous quantities of energy

Atom: one of the tiny particles of which all things are made

Nucleus: The small concentration of protons and neutrons, positively charged, at the center of atoms. The nuclei of atoms are positively charged and contain by far most of their mass (all but about 0.05% or less). The existence of the nucleus was deduced in 1911 by Ernest Rutherford, from experiments on the scattering of alpha particles by nuclei.

Neutron: A particle found in the nuclei of atoms, similar to a proton but with no electric charge. Among light nuclei (helium, carbon, nitrogen), the ones that are most stable contain equal numbers of protons and neutrons. In heavier elements, the most stable ones have majority of neutrons, growing with mass. Varieties of nuclei also exist ("isotopes") which have other ratios between their numbers of protons and neutrons, but when the departure from the "most stable ratio" becomes large, neutrons can convert to protons + electrons (or vice versa), producing one form of radioactivity.

Chain Reaction: A reaction in which some of the products initiate further reactions of the same kind allowing the reaction to become self-sustaining.

Energy Word Scramble

Name _____

Digital Learning Network

Date _____

Unscramble the words below:

1. YEGREN _____

2. TEHA FSNTARER _____

3. HWTGANVEEL _____

4. AROLS LELC _____

5. GTILH TRECSMPU _____

6. SATSM _____

7. YRSARA _____

8. UTITDATE _____

9. SMTAOCEIRHP _____

10. TPOVICALOHOT _____

11. AROLS YEGREN _____

12. ACENDGIU _____

13. VAGINOTINA _____

14. CPYOOGERS _____

15. CELAUNR _____

16. SNSOIF _____

17. EIICKNT _____

18. TABERYT _____

19. WEOPR _____

20. LNTTAIEOP _____

21. ISUOFN _____

22. MTOA _____

23. LNCUUSE _____

24. EOURTNN _____

25. IHANC TRACEOIN _____



Energy Vocabulary Word Scramble

Answers

1. YEGREN is Energy
2. TEHA FSNTARER is Heat Transfer
3. HWTGANVEEL is Wavelength
4. AROLS LELC is Solar Cell
5. GTILH TRECSMPU is Light Spectrum
6. SATSM is Masts
7. YRSARA is Arrays
8. UTITDATE is Attitude
9. SMTAOCEIRHP is Atmospheric
10. TPOVICALOHOT is Photovoltaic
11. AROLS YEGREN is Solar Energy
12. ACENDGIU is Guidance
13. VAGINOTINA is Navigation
14. CPYOOGERS is Gyroscope
15. CELAUNR is Nuclear
16. SNSOIF is Fission
17. EIICKNT is Kinetic
18. TABERYT is Battery
19. WEOPR is Power
20. LNTTAIEOP is Potential
21. ISUOFN is Fusion
22. MTOA is Atom
23. LNCUUSE is Nucleus
24. EOURTNN is Neutron
25. IHANC TRACEOIN is Chain Reaction



Resources

NASA Kids

For activities, games, stories and more, visit this website specifically designed for kids that are interested in space and NASA.

<http://www.nasa.gov/audience/forkids/home/index.html>



Background Information

For other activities on Energy for Grades 9-12:

Electromagnetic Spectrum Models

Students will construct a visual model of the electromagnetic spectrum and a logarithmic vs linear scale model.

http://dln.nasa.gov/dln/admin/media/download.jsp?file_id=1256



Contributors and Developers

Rene Flores	Johnson Space Center
Michelle Leggett	Johnson Space Center
Erin McKinley	Johnson Space Center
Michael Ewert	Johnson Space Center

Special Thanks to the following organizations and people: